

REMARKS

Claims 1, 5-17 and 19-22 are all the claims pending in the application. Claims 1, 21 and 22 have been amended.

Claim 1 has been amended for clarity and to further clearly point out the claimed subject matter. Claim 1 presently recites a gallium nitride compound semiconductor light-emitting device, wherein the individual well layers of the multiple quantum well structure each has the same composition (support at page 17, lines 23-28 of the specification, which describes alternately stacking an Si-doped n-type GaN barrier layer and an undoped Ga_yIn₂N well layer repeatedly (5 times)) and contains a thick portion having a large thickness and a thin portion having a small thickness and a portion having a thickness of 0 nm to 1.5 nm. Claim 1, as amended, further recites that the barrier layer is a barrier layer which is doped with a Group IV element at an average atom density of $1 \times 10^{17} \text{ cm}^{-3}$ to $5 \times 10^{18} \text{ cm}^{-3}$ for the purpose of decreasing the forward voltage of the device (support at page 16, lines 12-21 of the specification), and wherein the well layer is a discontinuous layer and the light-emitting layer has a region absent a well layer (support at page 13, lines 25-26 of the specification).

Claims 21 and 22 have been amended for clarity.

Entry of the Amendment is respectfully requested.

I. Claim Objection

Claims 21 and 22 were objected to. Specifically, the Examiner objected to the language “having the Ohmic electrode” of claims 21 and 22 as being unclear.

In response, claims 21 and 22 have been amended to recite that a minimum horizontal width (lateral width) of a metallic film constituting the Ohmic electrode is 10 μm or less.

Withdrawal of the foregoing claim objection to claims 21 and 22 is respectfully requested.

II. Rejection Under 35 U.S.C. § 112, 2nd Paragraph

Claims 1, 5-17 and 19-22 were rejected under 35 U.S.C. § 112, second paragraph as being indefinite. Particularly, the Examiner's position is that the term "low resistance" of claim 1 is a relative term that renders the claim indefinite.

Without acquiescing the merits of the above rejection, claim 1 has been amended to recite wherein the barrier layer is a barrier layer which is doped with a Group IV element at an average atom density of $1 \times 10^{17} \text{ cm}^{-3}$ to $5 \times 10^{18} \text{ cm}^{-3}$ for the purpose of decreasing the forward voltage of the device.

It is respectfully submitted that the present claims, as amended, fully comply with 35 U.S.C. §112, and withdrawal of the forgoing claim rejection is respectfully requested.

III. Rejections Under 35 U.S.C. § 103(a)

At paragraph (8) of the Action, claims 1, 5, 9-11, 16, 17 and 19 were rejected under 35 U.S.C. § 103(a) as allegedly being anticipated by Yamada (US 6,608,330 B1) in view of Sasaoka (US 2003/0042496 A1).

At paragraph (9) of the Action, claims 6-8 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamada in view of Sasaoka and Hanaoka et al. (US 5,804,839).

At paragraph (10) of the Action, claims 12, 13 and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamada in view of Sasaoka and Morita et al. (US 6,121,636).

At paragraph (11) of the Action, claim 14 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamada in view of Sasaoka and in further view of Kaneyama et al. (US 6,452,214 B2).

Applicants respectfully traverse the above rejections.

As claimed in amended claim 1, the individual well layers of the multiple quantum well structure each has the same composition and contains a thick portion having a large thickness and a thin portion having a small thickness and a portion having a thickness of 0 nm to 1.5 nm.

In contrast, Yamada discloses a light-emitting device including a first well layer and a second well layer that have different In composition ratios (Column 2 of Yamada, lines 1-7).

Further, Yamada states at Column 4, lines 16-35 the following: (1) generally, it has been understood that where the well layer has smoother growth surfaces with barrier layer and better crystallinity, then its luminous efficiency is improved; (2) there may be a certain interactive effect between the first and second well layers adjoining over the barrier layer; (3) in this case, when the degree of asperity of the second well layer emitting the longer wavelength light is greater than that of the first well layer emitting the shorter wavelength light, the shorter wavelength light from the first well layer is less absorbed in the second well layer; and (4) further, in this case, the degree of asperity of the second well layer can be optimized to improve the luminous efficiency of the second well layer.

First of all, Yamada teaches away from the claimed invention, because Yamada teaches that when the well layer has smoother growth surfaces with barrier layer and better crystallinity, its luminous efficiency is improved. Column 4, lines 16-35. In the present application, irregularities are formed in the interface between the well layer and the barrier layer.

Further, Yamada discloses that the second well layer may decrease light absorption and

exhibits an improved luminous efficiency when an interactive effect arises between the well layers having different In composition ratios. However, Yamada does not disclose the appearance of this effect in the first well layer. Yamada discloses that the decrease of light absorption and the improvement of luminous efficiency may appear only in either of the well layers when the interactive effect arises between the well layers having different In composition ratios.

The light-emitting device of Yamada includes at least two well layers (namely, the first well layer and the second well layer) having different In composition ratios and emitting different color light so that white light can be obtained by mixing the different color light (Column 2, lines 3-7). A desired color rendering property can be obtained by adjusting growth numbers of the first well layer and the second well layer (Column 2, lines 57-62).

Thus, according to Yamada, when the first well layer and the second well layer have the same composition, they would emit a single color light and would prevent the light-emitting device thus produced from obtaining a desired color rendering property.

Applicants believe that while the degree of asperity of the second well layer of Yamada having a long wave emission must be greater than that of the first well layer having a short wave emission (Claim 1 of Yamada), the first well layer of Yamada is not essentially required to possess asperity (Column 4, line 66 to Column 5, line 2).

Accordingly, Yamada does not disclose or teach a light-emitting layer of the multiple quantum well structure, wherein the individual well layers of the multiple quantum well structure each has the same composition and contains a thick portion having a large thickness and a thin portion having a small thickness and a portion having a thickness of 0 nm to 1.5 nm, as recited in present claim 1.

In addition, at page 4, paragraph (8) of the Action, the Examiner asserts that the barrier layer 107 disclosed in column 11, lines 7-8 of Yamada is equivalent to “a gallium nitride compound semiconductor barrier layer doped with an impurity element” of the present application. The Examiner contends that Yamada discloses that the layer 107 is formed of GaN, InGaN, AlGaN, or the like and that AlGaN may be considered to be doped GaN. Applicants respectfully disagree.

The expression “doping a semiconductor with an impurity” means variously controlling the band structure such as energy gap and the physical character besides adjusting the concentration of electrons and holes (carriers) in a semiconductor by adding a small amount of impurity.

Since the Si element is a tetravalent element unlike the Ga, In and Al elements, it has an effect of varying the carrier concentration in a semiconductor compound constituting a well layer. In contrast, since all of the Ga, In and Al elements are trivalent elements, the In and Al elements can be substituted for the Ga element constituting the semiconductor GaN, but have absolutely no effect of varying the concentration of electrons and holes (carriers) in the semiconductor GaN.

Thus, contrary to the Examiner’s assertion, Yamada does not disclose or suggest a gallium nitride compound semiconductor barrier layer doped with an impurity element, as required by claim 1.

Further, with regard to the secondary reference, Sasaoka does not disclose doping a semiconductor layer with impurity such as Si for the purpose of exhibiting low forward voltage and preventing variation of emission wavelength.

Specifically, the Examiner cited passage of Sasaoka, paragraph [0109], merely discloses

the doping of a well layer with Si, but does not disclose or teach the range of average atom concentration of the IV element necessary for lowering the forward voltage without varying the emission wavelength.

Each of Hanaoka, Morita and Kaneyama fails to make up the above noted deficiencies of Yamada and Sasaoka.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the present §103 rejections.

IV. Rejection of Claims 20-22 Under 35 U.S.C. § 103(a)

At paragraph (12) of the Action, claims 20-22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamada in view of Sasaoka and further in view of Lester (US 6,291,839 B1).

Applicants respectfully traverse this rejection.

Claims 20-22 depend primarily or secondarily from claim 1. Thus, claims 20-22 are patentable for at least the reasons discussed above with respect to the patentability of independent claim 1.

Claims 20-22 are further patentable over Yamada in viewed of the cited references for the following reasons.

In paragraph (12) of the Action, at page 14, the Examiner asserted that Lester discloses a gallium nitride compound semiconductor light-emitting device, wherein a horizontal width of the aperture is 0.5 μm to 50 μm . In this regard, the Examiner cited Col. 3, lines 21-22 of Lester as disclosing the dimensions of the openings. Applicants respectfully disagree.

The cited passage of Lester does not have the Examiner's asserted description equivalent to "a horizontal width of the aperture is 0.5 μm to 50 μm ". Rather, according to Lester, if the

dimension of the opening in p-type contact 20 of the Lester's light-emitting device exceeds 4 μ m, the LED will possibly have a "spotty" emission pattern (Column 3, lines 17-30).

Thus, the present claims are patentable over Yamada, in view of Sasaoka and Lester. Applicants respectfully request reconsideration and withdrawal of the present §103 rejection.

V. Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE

23373

CUSTOMER NUMBER

Date: March 27, 2009



Yan Lan
Registration No. 50,214